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SUBMERSIBLE MOTOR-DRIVEN PUMP WITH AN ANTI-FROST DEVICE

[0001] The present invention concerns a submersible motor-driven pump, which comprises a housing; an intake pipe mounted in the housing; an impeller mounted in the intake pipe to produce an intake flow and to convey a fluid to a discharge connection, said impeller being supported on a shaft connected to a motor; and a can into which the shaft extends.

[0002] Submersible motor-driven pumps are already known from the general state of the art. If they are installed in a pond or a liquid medium without freeze protection, they must be removed from their site of installation in the wintertime and stored where they are protected from freezing. In a submersible pump, an impeller is usually connected by a ceramic shaft to a motor, which drives the impeller when the pump is being operated.

[0003] It is well known that ceramic shafts are sensitive to pressure acting on them and can easily break. Nevertheless, ceramic shafts are preferred in known submersible pumps for their many other favorable properties.

[0004] In the winter, the liquid medium, which is not frostproof, freezes solid from the surface towards the bottom. If, for example, a submersible motor-driven pump spends the winter in a garden pond, it can freeze during a period of freezing weather. A submersible motor-driven pump of this type contains pond water that has remained in the housing since the last operation of the pump or has subsequently penetrated the chambers of the housing. This water slowly freezes solid from top to bottom and exerts pressure on the generally horizontally oriented shaft. When the ice formation in the housing progresses downward, and the water below the intake pipe, which is arranged laterally and concentrically with the shaft, also expands, the actual risk of fracture of the shaft due to freezing begins, especially in the case of a ceramic shaft.

[0005] Therefore, the objective of the invention is to develop a submersible motor-driven pump that can remain in a liquid and freezing medium, even during periods of freezing

weather, without sustaining any damage.

[0006] In accordance with the invention, this objective is achieved by installing an anti-freeze device for the shaft in the housing.

[0007] The anti-freeze device protects the shaft from freezing damage to a very great extent and protects it especially from freeze-related fracture.

[0008] Another advantage of the present invention is that the anti-freeze device is supported in an elastic bushing at the entrance to the can. Pressure transverse to a shaft axis X can be absorbed in this way.

[0009] Another advantage is that the anti-freeze device comprises a water displacer, which is arranged concentrically to the shaft or shaft axis X in free spaces. In particular, depending on the shaft length, there is a large free space in the can between the elastic bushing and a part of the motor that forms a rotor. The water displacer occupies a space in which the liquid medium and especially the freezing-susceptible pond water would otherwise collect and would exert pressure on the shaft. The water displacer thus keeps the water away from the shaft.

[0010] Another advantage is that the impeller is elastically mounted on the shaft. Elastic mounting of this type is accomplished, e.g., with an elastomer.

[0011] Still another advantage is that the lowest point of the water-containing region, generally a closed drain hole below the impeller, is closed with an elastic diaphragm that can expand when exposed to frost to absorb ice pressure from the shaft.

[0012] Specific embodiments of the present invention are described in greater detail below with reference to the drawings.

[0013] Figure 1 shows a schematic longitudinal section through a submersible motor-driven pump with an anti-freeze device in accordance with a first embodiment of the present invention.

[0014] Figure 2 shows a schematic detail view from Figure 1, which shows an elastic diaphragm in the expanded state in the right half and in the unexpanded state in the left half.

[0015] Figure 3 shows a schematic detail view from Figure 1, which shows an elastic impeller mounting.

[0016] Figure 4 shows a schematic longitudinal section through another submersible motor-driven pump with an anti-freeze device in accordance with a second embodiment of the present invention.

[0017] Figure 5 shows a schematic longitudinal section through another submersible motor-driven pump with an anti-freeze device in accordance with a third embodiment of the present invention.

[0018] Figure 1 shows a schematic longitudinal section through a submersible motor-driven pump 1 in its working or operating position. A housing 3 is connected with an intake pipe 5 at one of its end faces (left side in Figure 1). The intake pipe 5 is part of an intake housing 7, on which a pump connection 9 and a discharge connection 11 are also formed. An impeller 13, which is mounted on a shaft, especially a ceramic shaft 15, is installed in working connection with the intake pipe 5 and the pump connection 9 in the intake housing 7. The ceramic shaft 15 has a shaft axis X, which, in the illustrated operating position, extends in an essentially horizontal direction into a can 17, which is installed in the housing 3. The ceramic shaft 15 is supported at the junction between the intake housing 7 and the can 17 in a ceramic bearing 19, which in turn is supported in an elastic bushing 20. A water displacer 23, which fills a structural free space, is formed concentrically on the ceramic shaft 15 between the ceramic bearing 19 and a rotor 21 located on the ceramic shaft 25 in the can 17. The water displacer 23 preferably extends the same radial distance from the shaft axis X as the rotor 21, so that a more or less uniform air gap 25 is formed between the inner wall of the can 17 and the rotor 21 and water displacer 23. The air gap 25 can have a width of, for example, 0.2 mm.

[0019] The discharge connection 11 is located at the lowest point of the region of the submersible motor-driven pump 1 that contains water or other liquid medium and is separated from this region in the vertical direction by an elastic diaphragm 25. The left half of Figure 2 shows how the elastic diaphragm 25 is undeformed under normal pressure conditions of the water or other liquid medium. The right half of Figure 2 shows how the elastic diaphragm 25 is deformed by ice pressure when the liquid medium freezes.

[0020] The impeller 13 is also elastically mounted on the ceramic shaft 15. Figure 3 shows an elastic mounting 27 for the impeller 13, which holds the impeller on the ceramic shaft 15. In the present embodiment, the elastic mounting 27 for the impeller 13 is an elastomer, which is designed as an inner sleeve 31 between an outer sleeve 29 of the impeller 13 and the ceramic shaft 15 and extends over a portion of the length of the ceramic shaft 15 in the direction of the shaft axis X.

[0021] Each of the anti-freeze features of the submersible motor-driven pump,

namely, the elastic bushing 19, water displacer 23, elastic diaphragm 25, and elastic impeller mounting 27, by itself improves the freezing protection of the pump. The freezing protection is further optimized by the combination of the specified individual anti-freeze features. Therefore, in other embodiments, it is possible to use only some of the aforementioned anti-freeze features or any desired combinations of these features in a submersible motor-driven pump 1.

[0022] The choice of the elastic materials used for the features mentioned in the preceding paragraph depends on the subfreezing temperatures to be expected. Thus, it is possible to use any known state-of-the-art elastomeric materials that are dimensionally stable and water-resistant and do not lose their elastic properties even at subfreezing temperatures. Elastomeric materials of this type are known from the state of the art and include, for example, such elastomeric materials as natural or synthetic rubbers and rubber mixtures.

[0023] Figure 4 shows a schematic longitudinal section through a second embodiment of a submersible motor-driven pump 10 in a working or operating position. A housing 30 is connected with an intake pipe 50 at one of its end faces (left side in Figure 4). The intake pipe 50 is part of an intake housing 70, on which a pump connection 90 is also formed. An impeller 130, which is mounted on a shaft, especially an oxide ceramic shaft 150, is installed in working connection with the intake pipe 50 and the pump connection 90. The oxide ceramic shaft 150 has a shaft axis X, which, in the illustrated operating position, extends in an essentially horizontal direction into a can 170, which is installed in the housing 30.

[0024] The impeller 130 can be mounted on the oxide ceramic shaft 150 in the same way that is shown in Figure 3 for the first embodiment.

[0025] In the second embodiment in Figure 4, an annular space 190 is arranged in front of the intake housing 70 in the direction of the intake pipe 150. In the second embodiment with the annular space 190, the intake pipe 150 is screwed onto the intake housing 70. Other types of joints are also conceivable. A water displacer 210 is installed in the annular space 190. It consists, for example, of a closed-cell foamed plastic or a similar material that is well known from the state of the art. An air-filled membrane, similar to an expansion vessel in a heating system, is also conceivable, for example.

[0026] The annular space 190 is connected with the interior of the intake housing 70 by channels or slots 230. These slots 230 are distributed on the inside bordering on the periphery of the intake housing 70. Water/ice pressure can escape into the annular space 190

through these slots 230. In this embodiment, the submersible pump 10 can freeze in various spatial positions without being damaged by the water/ice pressure.

[0027] A third embodiment of a submersible pump 10 is shown schematically in Figure 5. The submersible pump 1 is identical to the submersible pump 10 of the second embodiment, except for the anti-freeze device, so that another general description is unnecessary. Corresponding parts are labeled with reference numbers that correspond to the reference numbers of the first and second embodiment. In this third embodiment, the anti-freeze device also includes an annular space 1900. However, it is arranged between the intake housing 70 and the can 170. The water displacer 210 is located in the annular space 1900 and can consist of the same materials as in the second embodiment. The annular space 1900 is connected by channels or slots 2300 with the interior of the can 170, on the one hand, and with the interior of the intake housing 70, on the other hand. The slots 2300 are also arranged here on the inside bordering on the periphery of the intake housing 70 and the can 170. In this way, the water/ice pressure can escape both from the can 170 and from the intake housing, and the submersible pump can freeze in various spatial positions without sustaining any freezing damage.

[0028] The third embodiment is suitable for so-called wet-running motors, in which the can 170 is filled with water.